

What is claimed is:

1. A leak detector for detecting a leak of a liquid injected through a needle into a blood vessel near the surface of a human body, comprising:
 - pulse generating means for sequentially emitting pulse signals toward the human body at a position at which said needle is inserted through wave propagation at a predetermined wavelength;
 - pulse detecting means for detecting said pulses reflected inside of said human body;
 - interval measuring means for measuring a time interval between the emission and the detection for each of said pulse signals;
 - difference calculating means for calculating the difference between the measured time interval and a predetermined reference time interval;
 - difference comparing means for comparing the calculated difference with a predetermined acceptable range; and
 - leak warning means for generating a leak warning for notification when the difference exceeds the acceptable range.
2. The leak detector according to claim 1, further comprising:
 - interval storing means for storing the measured interval at least until the next interval is measured,
 - wherein said difference calculating means employs the last measured interval as the reference interval for calculating the difference between the currently measured interval and the reference interval.
3. The leak detector according to claim 1, further comprising:
 - interval storing means for storing the first measured interval, wherein

said difference calculating means calculates the difference between the current measured interval and the first measured interval, said first measured interval being used as the reference interval; and

said difference comparing means compares the difference with a predetermined acceptable range.

4. The leak detector according to claim 1, further comprising graph display means for displaying the interval measured for each of said pulse signals in a trend graph representation.

5. A leak detector for detecting a leak of a liquid injected through a needle into a blood vessel near the surface of a human body, comprising:

pulse generating means for sequentially emitting pulse signals toward said human body at a position at which said needle is inserted through wave propagation at a predetermined wavelength;

pulse detecting means for detecting said pulses reflected inside of said human body;

wavelength measuring means for measuring a wavelength for each of said detected pulse signals;

difference calculating means for calculating the difference between the measured wavelength and a predetermined reference wavelength;

difference comparing means for comparing the calculated difference with a predetermined acceptable range; and

leak warning means for generating a leak warning for notification when the difference exceeds the acceptable range.

6. The leak detector according to claim 5, further comprising:

wavelength storing means for storing the measured wavelength at least until the next wavelength is measured,

wherein said difference calculating means calculates the difference between the currently measured wavelength and the last measured wavelength, said last measured wavelength being used as the reference wavelength.

7. The leak detector according to claim 5, further comprising:
wavelength storing means for storing the first wavelength, wherein
said difference calculating means calculates the difference between the first wavelength and the currently measured wavelength, said first wavelength being used as the reference wavelength; and

said difference comparing means compares the difference with a predetermined acceptable range.

8. The leak detector according to claim 5, further comprising graph display means for displaying the wavelength measured for each of said pulse signals in a trend graph representation.

9. The leak detector according to claim 1, further comprising graph display means for displaying the difference calculated for each of said pulse signals in a trend graph representation.

10. The leak detector according to claim 5, further comprising graph display means for displaying the difference calculated for each of said pulse signals in a trend graph representation.

11. The leak detector according to claim 1, wherein:
said pulse generating means emits said pulse signals comprised of ultrasonic waves, and
said pulse detecting means detects said ultrasonic pulse signals.
12. The leak detector according to claim 5, wherein:
said pulse generating means emits said pulse signals comprised of ultrasonic waves, and
said pulse detecting means detects said ultrasonic pulse signals.
13. The leak detector according to claim 1, wherein:
said pulse generating means emits said pulse signals of infrared rays, and
said pulse detecting means detects said infrared pulse signals.
14. The leak detector according to claim 5, wherein:
said pulse generating means emits said pulse signals of infrared rays, and
said pulse detecting means detects said infrared pulse signals.
15. The leak detector according to claim 13, wherein said pulse generating means emits said pulse signals of infrared rays at a frequency which transmit through a particular organ of the human body and is reflected by a particular organ of the human body.
16. The leak detector according to claim 14, wherein said pulse generating means emits said pulse signals of infrared rays at a frequency

which transmit through a particular organ of the human body and is reflected by a particular organ of the human body.

17. The leak detector according to claim 15, wherein said pulse detecting means detects only the infrared rays at said wavelength.

18. The leak detector according to claim 16, wherein said pulse detecting means detects only the infrared rays at said wavelength.

19. The leak detector according to claim 13, further comprising an optical filter for passing the infrared rays exclusively at said wavelength therethrough to said pulse detecting means.

20. The leak detector according to claim 14, further comprising an optical filter for passing the infrared rays exclusively at said wavelength therethrough to said pulse detecting means.

21. The leak detector according to claim 1, further comprising:
a leak detection unit including at least said pulse generating means and said pulse detecting means;
a detector body formed separately from said leak detection unit and including at least said leak warning means,
wherein said leak detection unit further includes radio transmitting means for transmitting a radio signal, and
said detector body further includes radio receiving means for receiving the radio signal.

22. The leak detector according to claim 5, further comprising:
a leak detection unit including at least said pulse generating means
and said pulse detecting means;
a detector body formed separately from said leak detection unit and
including at least said leak warning means,
wherein said leak detection unit further includes radio transmitting
means for transmitting a radio signal, and
said detector body further includes radio receiving means for
receiving the radio signal.
23. The leak detector according to claim 21, wherein said detector body
further includes:
reception detecting means for detecting a receiving state of the radio
signal; and
state notifying means for notifying the detected receiving state.
24. The leak detector according to claim 22, wherein said detector body
further includes:
reception detecting means for detecting a receiving state of the radio
signal; and
state notifying means for notifying the detected receiving state.
25. The leak detector according to claim 23, wherein said detector body
further includes a reception warning means for generating a reception warning
for notification when the detected receiving state falls below a predetermined
state.

26. The leak detector according to claim 24, wherein said detector body further includes a reception warning means for generating a reception warning for notification when the detected receiving state falls below a predetermined state.

27. The leak detector according to claim 1, further comprising:
imaging means for capturing an image of the human body at a position at which said needle is inserted; and
image display means for displaying the captured image.

28. The leak detector according to claim 5, further comprising:
imaging means for capturing an image of the human body at a position at which said needle is inserted; and
image display means for displaying the captured image.

29. The leak detector according to claim 21, wherein:
said leak detection unit further includes imaging means for capturing an image of the human body at a position at which said needle is inserted, and
said detector body further includes image display means for displaying the captured image.

30. The leak detector according to claim 22, wherein:
said leak detection unit further includes imaging means for capturing an image of the human body at a position at which said needle is inserted, and
said detector body further includes image display means for displaying the captured image.

31. The leak detector according to claim 1, further comprising:
a leak detection unit having at least said pulse generating means
and said pulse detecting means; and
a transparent adhesive pad for removably adhering said leak
detection unit on the surface of the human body, said adhesive pad being
marked with a position of said needle.
32. The leak detector according to claim 5, further comprising:
a leak detection unit having at least said pulse generating means
and said pulse detecting means; and
a transparent adhesive pad for removably adhering said leak
detection unit on the surface of the human body, said adhesive pad being
marked with a position of said needle.
33. The leak detector according to claim 31, wherein:
said adhesive pad is replaceably formed separately from said leak
detection unit; and
said adhesive pad is additionally marked with a position of said leak
detection unit.
34. The leak detector according to claim 32, wherein:
said adhesive pad is replaceably formed separately from said leak
detection unit; and
said adhesive pad is additionally marked with a position of said leak
detection unit.
35. The leak detector according to claim 31, further comprising a

replaceable protection member formed integrally with said adhesive pad for enclosing said leak detection unit, said protection member being transparent to the wave propagation.

36. The leak detector according to claim 32, further comprising a replaceable protection member formed integrally with said adhesive pad for enclosing said leak detection unit, said protection member being transparent to the wave propagation.

37. The leak detector according to claim 1, further comprising:
a leak detection unit having at least said pulse generating means and said pulse detecting means; and
a replaceable protection member for enclosing said leak detection unit, said protection member being transparent to the wave propagation.

38. The leak detector according to claim 5, further comprising:
a leak detection unit having at least said pulse generating means and said pulse detecting means; and
a replaceable protection member for enclosing said leak detection unit, said protection member being transparent to the wave propagation.

39. The leak detector according to claim 1, wherein said leak detector comprises a plurality of at least one of said pulse generating means and said pulse detecting means.

40. The leak detector according to claim 5, wherein said leak detector comprises a plurality of at least one of said pulse generating means and said

pulse detecting means.

41. The leak detector according to claim 1, further comprising:
an extension tube for leading the liquid to said needle; and
tube blocking means for blocking said extension tube when the
difference exceeds the acceptable range.

42. The leak detector according to claim 5, further comprising:
an extension tube for leading the liquid to said needle; and
tube blocking means for blocking said extension tube when the
difference exceeds the acceptable range.

43. A leak detecting method for detecting a leak of a liquid injected
through a needle into a blood vessel near the surface of a human body, said
method comprising the steps of:
sequentially emitting pulse signals of infrared rays at a
predetermined wavelength toward the human body at a position at which said
needle is inserted;
detecting said pulse signals reflected inside of the human body;
measuring a time interval between the emission and the detection
for each of said pulse signals;
calculating a difference between the measured interval and a
reference time interval;
comparing the calculated difference with a predetermined
acceptable range; and
generating a leak warning for notification when the difference
exceeds the acceptable range.

44. The leak detecting method according to claim 43, wherein:
said step of measuring includes storing the measured interval at least until the next interval is measured, and
said step of calculating includes employing the last measured interval as the reference interval for calculating the difference between the currently measured interval and the reference interval.
45. The leak detecting method according to claim 43, further comprising the step of:
storing the first measured interval,
wherein said step of calculating includes calculating the difference between the currently measured interval and the first measured interval, said first measured interval being used as the reference interval.
46. The leak detecting method according to claim 43, further comprising the step of displaying the interval measured for each of said pulse signals in a trend graph representation.
47. A leak detecting method for detecting a leak of a liquid injected through a needle into a blood vessel near the surface of a human body, said method comprising the steps of:
sequentially emitting infrared pulse signals at a predetermined wavelength toward said human body at a position at which said needle is inserted;
detecting said pulses reflected inside of said human body;
measuring a wavelength for each of said detected pulse signals;

calculating the difference between the measured wavelength and a predetermined reference wavelength;

comparing the calculated difference with a predetermined acceptable range; and

generating a leak warning for notification when the difference exceeds the acceptable range.

48. The leak detecting method according to claim 47, wherein:
said step of measuring includes storing the measured wavelength at least until the next wavelength is measured, and
said step of calculating includes calculating the difference between the currently measured wavelength and the last measured wavelength, said last measured wavelength being used as the reference wavelength.

49. The leak detecting method according to claim 47, further comprising the step of:
storing the first wavelength;
wherein said step of calculating includes calculating the difference between the currently measured wavelength and the first wavelength, said first wavelength being used as the reference wavelength.

50. The leak detecting method according to claim 47, further comprising the step of displaying the wavelength measured for each of said pulse signals in a trend graph representation.

51. The leak detecting method according to claim 43, further comprising the step of displaying the difference calculated for each of said pulse signals in

a trend graph representation.

52. The leak detecting method according to claim 47, further comprising the step of displaying the difference calculated for each of said pulse signals in a trend graph representation.

53. A liquid injector for pressing a piston member into a cylinder member filled with a liquid of a liquid syringe coupled to a human body through a needle and an extension tube, said liquid injector comprising:

the leak detector according to claim 1; and

injection suspending means for suspending injection of the liquid when said leak detector generates the leak warning for notification.

54. A liquid injector for pressing a piston member into a cylinder member filled with a liquid of a liquid syringe coupled to a human body through a needle and an extension tube, said liquid injector comprising:

the leak detector according to claim 5; and

injection suspending means for suspending injection of the liquid when said leak detector generates the leak warning for notification.

55. A liquid injector for pressing a piston member into a cylinder member filled with a liquid of a liquid syringe coupled to a human body through a needle and an extension tube, said liquid injector comprising:

the leak detector according to claim 25; and

injection suspending means for suspending injection of the liquid when said leak detector generates at least one of the leak warning and the reception warning for notification.

56. A liquid injector for pressing a piston member into a cylinder member filled with a liquid of a liquid syringe coupled to a human body through a needle and an extension tube, said liquid injector comprising:

the leak detector according to claim 26; and

injection suspending means for suspending injection of the liquid when said leak detector generates at least one of the leak warning and the reception warning for notification.

57. An adhesive pad for use with the leak detector according to claim 33, wherein said adhesive pad is marked with a position of said needle and a position of said leak detection unit.

58. An adhesive pad for use with the leak detector according to claim 34, wherein said adhesive pad is marked with a position of said needle and a position of said leak detection unit.

59. The adhesive pad according to claim 57, comprising a replaceable protection member integrally formed therewith for enclosing said leak detection unit, said protection member being transparent to the wave propagation.

60. The adhesive pad according to claim 58, comprising a replaceable protection member integrally formed therewith for enclosing said leak detection unit, said protection member being transparent to the wave propagation.